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Designing a Healthy Puget Sound and Salish Sea: Ten Commandments

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Good morning and thank you for the opportunity to present to you today. I know that I am preaching to the choir here and that you don't need much convincing that Puget Sound its wildlife are some of the region's most precious resources; both above the water and below the water. And, I think you know that because of coastal development, contaminants, overharvest and a myriad of other synergistic factors, this system has been changed dramatically.

When we look back to other cultures that have had ecological-based collapse such as the great Mayan empire, the Anasazi of the desert southwest or even cultures in more temperate climates like Easter Island; we see a history of natural resource depletion, ecological collapse and social upheaval. We see what not to do but we don't see a lot of stories about what we can do as we work to design a healthy Puget Sound.

That's even the case if we look at great efforts of this day and age that are working to redesign ecosystems like the Florida Everglades, where we have spent billions of dollars to restore an ecosystem. In short, we don't have a model that we can use for the designing a health Salish Sea.

We spend a lot of time telling people what to do, but not really telling them why. Here you see examples: 50 Ways to save the Ocean by David Helvarg; a list of 10 things you can do to save the ocean; a list of fish not to eat. These are great and people want these things, but telling people what to do without telling them why doesn't empower people to make good decisions – we're just making the decision for them. What's a legislator going to do when faced with a decision to increase shipping to the ports of Seattle and Tacoma? How will they weigh that with what this could do to increase risk of oil spills or ambient underwater noise and their constituent's concerns about the health of the southern resident killer whale population? Are they going to find the answer on this list of 10 things you can do to save the ocean? No.

I was at a recent public meeting and a citizen basically said, "You scientists are arrogant." Well they actually used a different work for scientists, but they did say arrogant. They said "you think you can come in and tell us what is going on and what we can do." My first reaction was well, yes, we do understand what is happing and we want to tell you what to do" but then as I thought

about it, I realized that he was right. There is no reason that science has to come down from above. And then I thought, well what if it did? Would it look like this cartoon of 10 Commandments for Designing Healthy Coastal Ecosystems?

And that really started this project of identifying the top ecological principles that we KNOW we need to account for to design a healthy ecosystem. What if we could somehow get everybody in the region to understand them, not just the science geeks and policy wonks, but everybody? Maybe our ecosystem could become the model ecosystem that others use to talk about how to design a healthy ecosystem. We need to empower the people of the region to understand the ecosystem and the implications of what we are doing to it and how we need to think about designing it.

And let me point out that we are talking about designing healthy ecosystems, not restoring. Restoration implies a return to some prior condition that might not be attainable in this day and age. Design acknowledges that humans are an integral part of the ecosystem and that we have the power to change it; for better or for worse.

So briefly, what are these ecological principles or "Commandments?"

The first is think ecosystem. There is a lot of effort now by Washington State to restore Puget Sound by the year 2020, but Puget Sound is just half of a large and unified ecosystem often called the Salish Sea. The Salish Sea has 7,470 km of shorelines and 16,925 sq km of water. The oceanographic and biological features of this ecosystem, such as the currents and the animals, don't recognize the arbitrary international boarder bisecting this ecosystem.

Well what can happen when you don't focus on the ecosystem? We have five species of Pacific salmon and numerous stocks that move from fresh water out into the open ocean and back into the fresh water at the end of their lives. In 1945, the United States and Canada implemented the first bilateral Pacific salmon-sharing agreement, followed by the 1985 Pacific Salmon Treaty. However these agreements unraveled as resources became scarce. By 1997, as salmon stocks were declining, accusations from both sides about the interception and harvest of fish destined for the other country became so heated that the USA and Canada independently shifted their fishery regimes, foregoing all concerns about stock declines. To quote Carl Safina, "when you fish like there is no tomorrow that's what you get, no tomorrow." Fortunately these "salmon wars" ultimately culminated in a renewed salmon harvest agreement signed in 1999.

Problems at political boundaries can be ameliorated with cooperation a commitment; ecological boundaries are immutable. We need to be looking at the Salish Sea as an ecosystem. This means including it in our Puget Sound plan. In your Biennial Science Work-plan are we modeling land use in BC? What about identifying stressors affecting the pelagic food web in BC? What about species recovery?

When you bring up the need to synthesize, integrate and communicate current best answers, we need to include BC. How about moving from a State of the Sound and Puget Sound Update to a State of the Salish Sea and Salish Sea Update?

Next, account for ecosystem connectivity. We need to recognize that our ecosystem is more interconnected that we can really begin to imagine. We are connected by the species. Gray whales that come here connect us to Baja and the Bering Sea. Scoters, which have declined by 50% over the last 25 years, connect us to other areas. As you see on this WDFW map of satellite tracks, these birds leave Puget Sound and go almost to the Arctic circle to breed.

Commerce and transportation are powerful non-biological forces that link the biota of Puget Sound to other ecosystems. In 2006-2007 Washington State and tribal fishermen harvested over 225 metric tons of sea cucumbers, the majority of which were exported to Asian markets. Increasing non-local demand for fisheries can potentially drive unsustainable harvest and hinder restoration.

Based on total waterborne trade in dollars, in 2005 the Puget Sound ports of Seattle and Tacoma ranked seven and nine in the United States, respectively. While most of Seattle's top trading partners of 2005 were in Asia, the Port of Seattle alone registered trade with 172 countries around the world. This trade creates immense potential for oil spills and the introduction of invasive species.

While it is tempting to filter out the apparent "noise" from other species and ecosystems, acknowledging and identifying key cross-species and cross-habitat connections are essential to understanding changes in the system and measuring performance.

Great thinkers and philosophers from Henry David Thoreau to Edward O. Wilson have espoused the global interdependence of people and other parts of nature that is inescapable in designing sustainable communities; account for ecosystem connectivity.

Understanding the food web is the next critical principle we need to remember. Knowing the food web allows us to account for connectivity in the ecosystem as we just discussed. Also, it allows us to understand where critical species exist and how we can better manage them.

As we see here on this slide, based on harbor seal biopsy data collected by WDFW, DFO and others, we see that the food web can help us understand the movement of contaminants through the system. Harbor seals are integrated collectors of information on contaminants and are good indicators of contaminants in the ecosystem, collected from WDFW and others. We see here that PCB levels are higher in seals from south sound and that as you move north into the Strait of Georgia, dioxin and furan levels because of the pulp mills.

A few years ago the SeaDoc Society funded a project to evaluate the impact of a growing eagle population on marine birds. Breeding nest surveys of eagles show that marine birds comprise 60-

80% food remains found. Rob Bulter has been studying this and has data showing that good runs of salmon provide a respite from eagle predation for marine birds. When the salmon are up the rivers, so are the eagles. This just so happens to correspond to when marine birds come here to molt; lose their feathers and grow new ones. Information on the food web helps explain to people how everything is connected such as how salmon recovery is important for marine bird recovery.

Knowing how plants and animals are related to each other by their diets is a practical way to visualize connectivity, interdependence, and system integrity and helps predict how nature will respond to stresses; understand your food web. The Science Panel recognizes this and you have called this out as a research need in the Biennial Science Plan.

Next, avoid fragmentation. Fragmentation is the breaking of ecosystems or landscapes or seascapes into smaller and smaller pieces, which upsets the natural integrity of the system (which we'll talk about in a minute) and breaks up the connections. Here you see a picture taken by Hugh Shipman of a bulk head separating a feeder bluff from the sound. Now a feeder bluff is designed to feed dirt and material into the area, hence its name. It is producing a beach elsewhere or sand waves under the water and bulkheads fragmenting the system stop the natural processes of an intact system.

When we removed shoreline vegetation it decreases the amount of contaminants that are filtered as water moves from fresh water into the ocean and it can impact the delivery of terrestrial insects to the marine water, where they are fed upon by species like juvenile salmon.

Habitats of adequate size and quality to support high levels of biodiversity are critical characteristics of healthy ecosystems; avoid fragmentation. You guys recognize the need to avoid fragmentation and once again, called it out as a need for scientific investigation in the Biennial Science Plan.

Respect ecological integrity. Ecological integrity, in which a system has all its parts and no "extra" ones, is a hallmark of environmental health. An intact ecosystem has a complete suite of species, and a full range of size and age classes of each component species. Ignoring the ecological integrity and the power of biological interdependence in marine systems has been catastrophic. We modify integrity by removing important parts. So, even just by doing something as simple as removing large adult rockfish fish, we can greatly reduce the integrity of a system. You see, large adult rockfish produce not only more juveniles, we know that for some species, their young are more likely to survive than the young of smaller, younger females.

The introduction of non-native species also impacts ecosystem integrity. One example is the introduction of the non-native seaweed *Sargassum muticum*, which thanks to 3 years of SeaDoc-funded work conducted by Kevin Britton-Simmons and others, we not know is capable of outcompeting native kelp and impacting the growth of green urchins that feed on that kelp.

Introducing contaminants like we discussed with PCB's, dioxins and furans also upsets ecological integrity by adding parts. Loss of integrity threatens nature's stability, beauty, and capacity for self-renewal, but integrity can be rebuilt and sustained by design; respect ecosystem integrity.

Support nature's resilience. Resilience, or nature's ability to roll with the punches, is essential in a healthy ecosystem. We know this but still it is frequently ignored in conservation planning. This is because it is hard to measure, and often only recognized once the system is on the verge of collapse.

Nick Brown and I recently did a study looking at 26 threatened and endangered species in the Salish Sea and based on the status reviews and recovery plans written for these species, identified listed causes for decline. What you'll notice is that all of these causes for declines (overharvest, contaminants, habitat loss, bycatch and others) add up to well over 100%. That is because for almost all species, their declines are caused by multiple factors, not just one. Multiple stressors reduce resiliency and make it more difficult to roll with the punches.

Many things have been shown to help nature stay resilient; maintaining genetic diversity increases resilience in eelgrass communities. While healthy ecosystems have tremendous capacity for self-renewal, resilience can be overwhelmed by collective human activities. Again, resilience can be restored by people, by design.

A healthy ecosystem is like money in our pockets. The financing chapter of the Draft Action Agenda states that Puget Sound provides direct economic benefit of more than $3.5 billion per year to the regional economy. On-the-water activities account for 80% of all the money spent on tourism and recreation in Washington State every year and the value of the overall whale-watching industry in the Salish Sea worth $66.2 million annually. The ports of Seattle and Tacoma (remember, 5th and 7th largest in the country) enable over $70 billion in international trade. Having a healthy ecosystem is an integral part of having a healthy economy. We need to be able to explain that to legislators who can easily (or could easily see) the 16,000 people at a Sonics game. They don't even care if that's the fifth lowest average attendance of all 30 NBA teams. They multiply each person by the cost of a ticket and see value. We need to show them the value of a healthy ecosystem.

Fecal coliform contamination of nearshore waters closed a third of Washington's $97 million shellfish beds to harvest in one year alone. How much larger could that industry be with no closures? Or, what is the hidden cost to the region's health care industry or to the loss of work hours from people getting sick from eating unhealthy shellfish in the region? Nobody knows.

The Science Panel has encouraged the use of a conceptual model to provide a framework for understanding how people and the ecosystem interact. You understand that healthy ecosystems are money in our pocket because they save on repair costs and deliver essential goods and services.

Next, watch wildlife health. As a veterinarian, asking me about the importance of wildlife health is like asking a barber if you need a haircut… of course we will say. But let me remind you, wildlife health is important for wildlife, but also tells us a lot about diseases that can impact humans and domestic animals, as well as tell us about how changes in the ecosystem can be impacting our health. For example, in the last 5 years, approximately 25 porpoise have died of a fungus called *Cryptococcus gattii*; big deal you say, but the disease also has impacted over a hundred people as well as cats, dogs, and other domestic animals. And, the first case showed up in a porpoise in Washington state, years before it showed up in a person or a domestic animal.

Toxoplasma gondii is a parasite carried by domestic cats. We know from monitoring wildlife health that wildlife exposure to this parasite from a land mammal is increased in areas where freshwater run-off into the marine environment has been modified. We also know that exposure is increased in areas of increased population density. Sure this parasite can cause fatal brain disease in river otters, sea otters and seals, but its infective stage also can be concentrated in filter feeding bivalves like oysters, which can then infect people if they are eaten raw. Watching wildlife health can warn us of impending human health problems and can tell us where the ecosystem needs repair.

Plan for nature's variability. Rare extreme events like wildfires, hurricanes, droughts, floods, and El Niño Southern Oscillation events have played an important part in sustaining biodiversity and ecological integrity in oceans. As citizens, scientists and decision makers begin to envision a restored Salish Sea that vision must include policies, laws, and management actions that account for extreme but natural events. Extreme natural events test fitness, mediate competition, and assure diverse opportunities, we need to plan for that.

Finally, people matter from grassroots to government and little will happen without educating and incorporating humans at every level into designing a healthy ecosystem for the future. We need to share our knowledge about the ecosystem.

Even if the scientists know what to do and the policy people do it, there is no guarantee that something will get done. This is a picture of George the First. In the early 1700's George the First recognized the need to protect salmon. Being the king he in 1714 he enacted a law to prevent blocking salmon from their spawning grounds in seventeen English rivers. Six years later the first modern factory, a water-powered silk mill, was built along a salmon stream in Derby. By 1868, all seventeen rivers protected by George I were either blocked or poisoned by pollution.

Conversely, even if the public supports making decisions that support health ecosystems, if you have leaders who don't understand the social and financial importance of having a healthy ecosystem, policy makers will be unable to make the difficult decisions needed. Only an educated and dedicated political leadership demonstrating vision and stamina will keep a long-term focus on restoring ecosystems in the face of numerous short-term competing interests.

So, as scientists, what is our role in disseminating these basic ecological principles so that they become a part of the collective consciousness of the people of the region? How do we make these part of the region's ocean literacy? Let's discuss…

Thank you!
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Note: this talk was developed from a manuscript that is in press at the international journal *EcoHealth*.[1] I thank my co-authors for their major contributions to this presentation.

[1]Gaydos, J. K., L. Dierauf, G. Kirby, D. Brosnan, K. Gilardi and G. E. Davis. In Press. Top Ten Principles for Designing Healthy Coastal Ecosystems like the Salish Sea. *EcoHealth*